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NUCLEAR POWER

Chernobyl accident: Can it happen here?

Differences between US and Soviet plants may be less than first thought, critics say; industry says US made the right choices

By Larry Tye
Globe Staff

Even as the Soviets were scrambling to contain radioactivity pouring from the crippled Chernobyl reactor, the US nuclear industry was insisting that kind of accident cannot happen here.

But as government and independent scientists pored through technical documents and CIA photographs after the accident they realized that, contrary to industry claims, key parts of the Soviet reactor were encased in a huge concrete and steel shell similar to those surrounding US plants. And at Chernobyl, that containment structure was blown apart.

Then they learned that the Soviet plant, like many in the United States, was equipped with a subterranean pool with millions of gallons of water to absorb leaking steam, and fire walls to protect the cables controlling the plant's dual safety systems. But fire apparently engulfed everything at Chernobyl as radioactive steam spewed from the reactor, according to US government accounts.

Finally, they found that at Chernobyl, as at many US reactors, oxygen is pumped out of the chamber around the reactor vessel to prevent it from mixing with hydrogen and exploding. But at Chernobyl, hydrogen formed and exploded anyway.

"The industry was too quick in dismissing this," said James Asselstine, a Nuclear Regulatory Commission member who made public the similarities between Chernobyl and many US plants.

"And, in fact, the NRC was too quick in dismissing this accident as having no implications for the US nuclear program," he added in a telephone interview.

Victor Gilinsky, a former NRC commissioner, agreed: "The sensible reaction after this accident is to check out that we're as good as we think we are. A lot of smart people worked on the Soviet reactor, too, and they thought they had the problems solved. But they didn't."

David Crowley, spokesman for General Electric Co., which designs nuclear plants, concedes that the industry – along with everyone else – "overspeculated" immediately after the accident. But, he said, "it was just an honest attempt to share information as best as it was received."

Crowley added that it would be equally wrong to overestimate the similarities between Chernobyl and US plants. US reactors are far less likely to have a runaway reaction like the one at Chernobyl, to explode or to burn, he said – and they are more likely to withstand accidents.

Gilinksy acknowledged that doubts remain about similarities between US and Soviet nuclear plants. But while they are being resolved, he said, the US should err on the side of caution.

One issue that deserves immediate attention, the former commissioner said, is how the accident started: Soviet officials have said that while they were testing the reactor, it surged from 6 percent of its power-production capacity to 50 percent in less than 10 seconds. That means the

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of the errors detected by Stewart and Feder. Indeed, the Journal retracted Dersee's papers in 1983, editorializing that even careful scrutiny cannot always uncover cleverly-done fraud.

"We thought we dealt with this 10 years ago, but now we should look at it with a fresh eye to make sure we're not vulnerable to very rapidly accelerating accidents of this sort," Gilinsky said.

Other specialists say there already is evidence that US reactors are vulnerable to problems experienced at Chernobyl.

In 1972, for instance, valves controlling the flow of steam from the reactor building to the cooling pool at the Quad Cities plant in Illinois were stuck partly open, although a control panel indicated they were closed. That is precisely the kind of equipment failure that experts say could disable safety equipment – and allow steam to break through the containment – during an accident like the one at Chernobyl.

Three years later, a fire at the Browns Ferry plant in Alabama destroyed cables controlling primary and backup safety systems, just as it apparently did at Chernobyl.

And in 1979, in the worst US nuclear power plant accident, hydrogen gases collected in Pennsylvania's Three Mile Island plant and caused what government officials say was a minor explosion.

Accidents are possible

"We have had a lot of problems before," said Robert Pollard, a former NRC safety official now with the Union of Concerned Scientists, a group critical of nuclear power. "So far we have gotten away with them, but their frequency and nature suggests if we don't do something, we're going to have a major accident."

US plants are susceptible to hydrogen explosions, Pollard said. The hydrogen is released when water in the core heats to twice its normal temperature following an accident, and steam reacts with the zirconium metal wrapped around the uranium fuel.

Usually the reactor building is filled with nitrogen gas that displaces oxygen, which could react with hydrogen and cause an explosion. During startup and shutdown procedures, however, oxygen is pumped back in so employees can service the reactor.

"But those are the times when an accident is most likely because people are manipulating the system, starting and stopping pumps," Pollard said. "If you are running at steady state nobody is doing anything where they can make a mistake.

"The accident [and the hydrogen explosion] at Chernobyl apparently happened when they were shutting the plant down."

Similar containment

Nuclear scientists also are concerned about the destruction of Chernobyl's containment, which was reportedly able to withstand 57 pounds of pressure per square inch, about the same as those at US plants.

Even before the Soviet accident, NRC had launched a review of the adequacy of containments at US plants, and it probably will recommend "building in more safety than what we've got now," said Herbert Kouts, director of that review and chairman of the Department of Nuclear Energy at Brookhaven National Laboratory.

One possibility, Kouts said, is adding an outer layering to allow the slow release of steam during an accident; radioactive gases would be filtered out and the steam would be vented to the air. This system, already in use in Sweden and France, offers further protection for nearby residents and relieves pressure that could puncture the containment.

Most specialists agree that Soviet reactors have features that make them more dangerous, and that the Soviets probably have less rigorous safety regulations than the United States.

But Brian Sheron, NRC's deputy director of safety review and oversight, goes a step further – arguing that Chernobyl confirms some safety decisions made in the United States.

US power plants, for instance, use water rather than graphite to sustain the nuclear reaction. When graphite is exposed to high temperatures and steam during an accident, it can release carbon monoxide and hydrogen – both highly reactive, and both possible culprits in the explosions at Chernobyl, Sheron said.

Also, the containment at Chernobyl "is not in any way, shape or form what is put on Western-style reactors," he said. While the Soviet reactor core was enclosed, some pipes and other safety equipment were "open to the environment, so if you had a failure of pressure tubes, steam from the core would have a direct path to the environment."

Robert Bernero, another senior NRC safety official, agreed: "Anyone who says there is a striking resemblance between Chernobyl and US plants is just stretching the truth to make a point, or just not looking at it."

Problems highlighted

Asselstine takes a middle ground, saying Chernobyl has highlighted problems at US plants but insisting they can be solved – provided NRC and the industry take three steps.

First, they must systematically review each plant for design weaknesses. The industry also should improve management, equipment and training. And designs must be upgraded to reduce the chance of meltdowns and other accidents.

Without those changes, the chance of Chernobyl-type accidents is disturbingly large, said Daniel Ford, former director of the Union of Concerned Scientists.

A 1981 study by two top government safety officials concluded that each US reactor currently faces a 1-in-2,000 chance of a serious accident every year, Ford said.

"That means the United States faces a 50 percent chance of having a Chernobyl or something like it this decade," he added. "And worldwide, there would be one meltdown every three years. It's not prophecy, it's just arithmetic."

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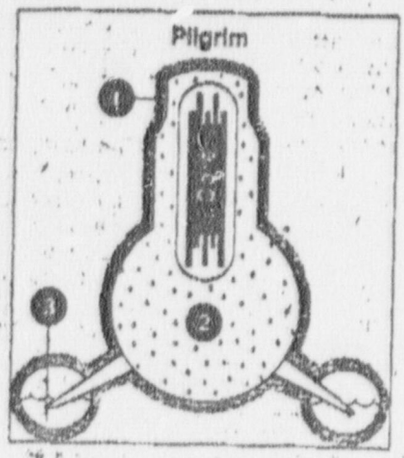
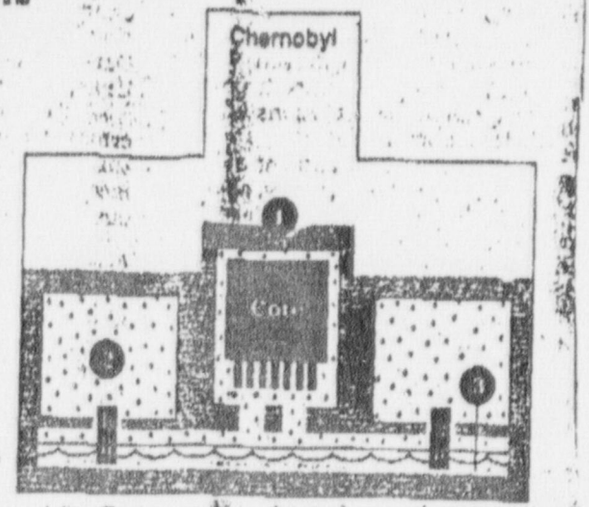
Critical safety systems at Chernobyl and Pilgrim plants.

1. Steel containment structure reinforced by concrete.
2. Nitrogen gas to prevent any hydrogen that leaks from exploding.
3. Cooling pools to absorb steam leaking from the reactor after an accident.





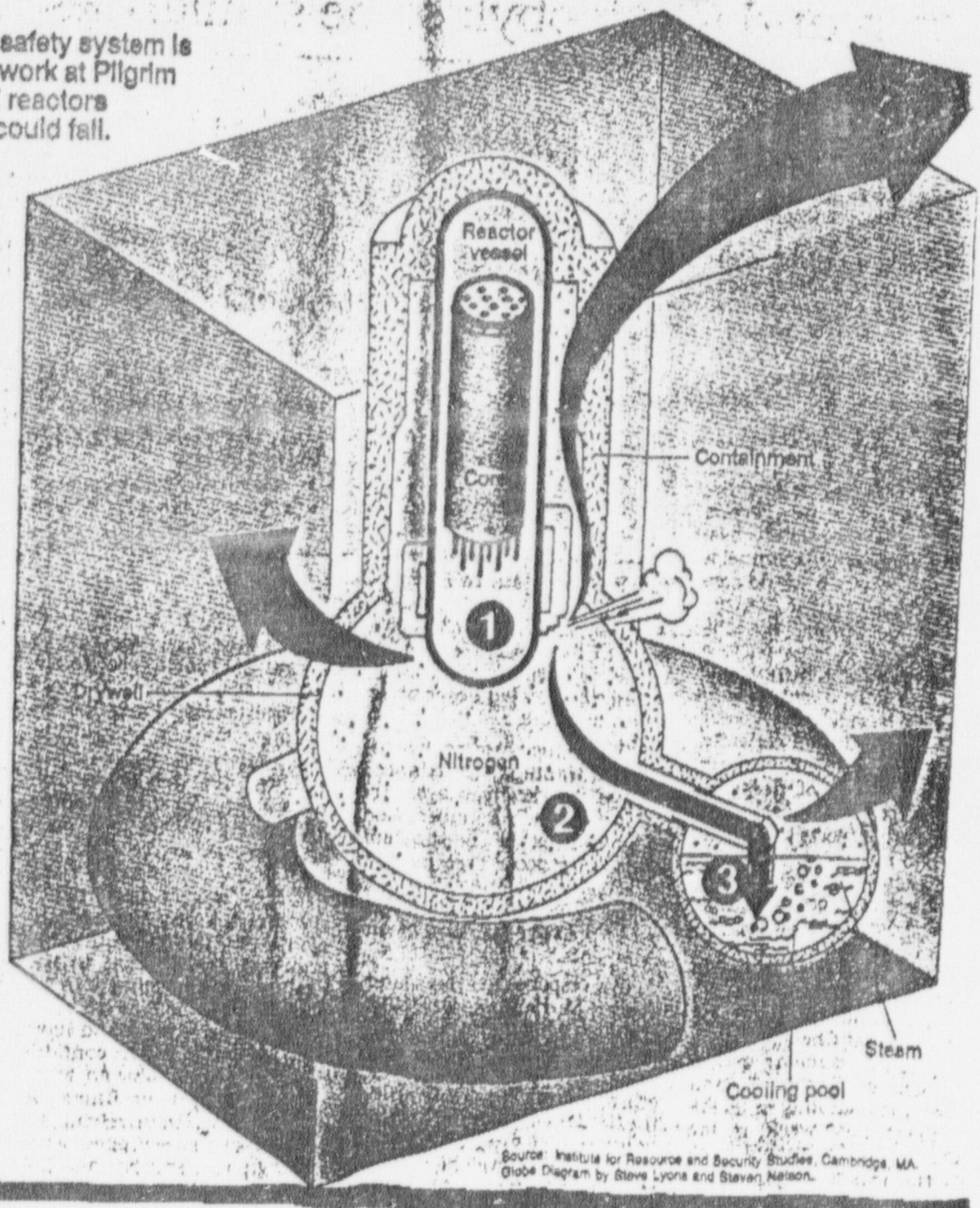
How a major safety system is supposed to work at Pilgrim and other GE reactors -- and how it could fail.

1. A steam or water pipe running to the reactor vessel breaks. Boiling water surrounding the reactor core pours into the drywell, where it turns to steam.

2. Steam fills the drywell, mixing with nitrogen gas designed to prevent an explosion of hydrogen gas that might leak from the reactor. Pressure builds.

3. If everything goes right, steam and nitrogen are funneled to a cooling pool in a huge chamber. There, steam is condensed, and nitrogen collects above the pool. Meanwhile, water is taken from the pool to cool the reactor and nitrogen is circulated back to the drywell.

4. But if a valve sticks, a weld breaks or something else goes wrong, the steam may never make it into the cold water. Instead, it can build up and rupture the drywell or other structure, allowing radioactive gases to leak outdoors.



Source: Institute for Resource and Security Studies, Cambridge, MA.
Globe Diagram by Steve Lyons and Steven Nelson.

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Pilgrim and Chernobyl: some similarities

The Pilgrim nuclear power plant in Plymouth has some features in common with the disabled Chernobyl reactor – a prospect that worries some nuclear safety experts.

Like the Soviet reactor, Pilgrim and 38 other US plants designed by General Electric Co. have huge ponds of water – called pressure supression pools – under the reactor.

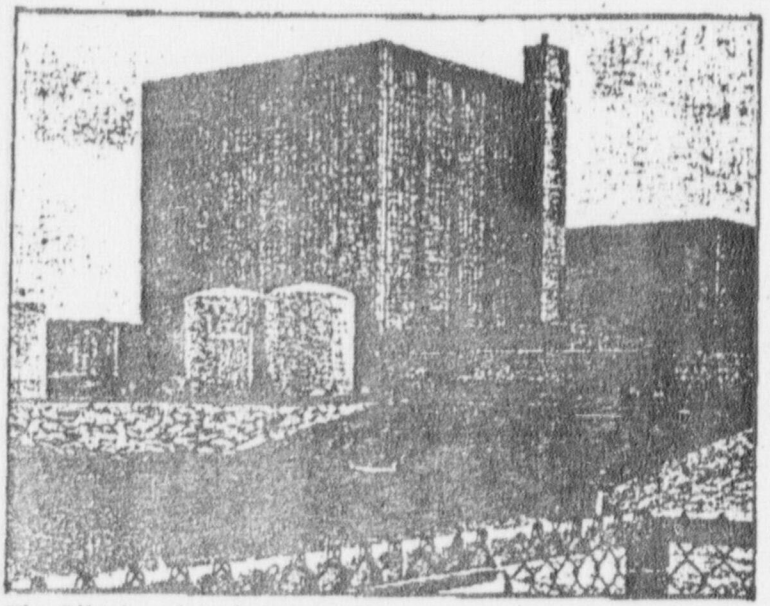
If the reactor is punctured by a broken pipe or other accident, water used to cool the hot radioactive fuel would pour out and turn to steam. Before the steam can reach dangerous pressure, however, safety systems are supposed to channel it to the pool, where it would condense and turn back to water.

As further protection, Pilgrim's reactor is encased in a lightbulb-shaped building – called a drywell – with three-quarter-inch steel walls reinforced with six feet of concrete, able to withstand 62 pounds per square inch of pressure from steam or other gases. Contrary to early reports that Chernobyl had no containment, the Soviet reactor also was protected by steel and concrete that can withstand about 57 pounds of pressure.

But safety systems do not always work as intended, as seen in scores of accidents at US plants – and at Chernobyl.

For years, nuclear critics have debated Boston Edison Co. over the reliability of its Pilgrim plant. Last week, in the wake of the Chernobyl accident, the Union of Concerned Scientists renewed the debate by releasing internal Nuclear Regulatory Commission documents questioning the safety of Pilgrim and other GE plants.

In a 1972 letter released by UCS, the NRC's former top safety official, Stephen Hanauer, worried that valves leading to the cooling pool could stick or other equipment malfunction, causing steam to collect in the reactor building and break through the containment.



The Pilgrim plant in Plymouth.

A radioactive leak also could occur if too much steam went to the cooling pools or too much hydrogen collected near the reactor, he wrote.

"While they also have some safety advantages, on balance I believe the disadvantages are preponderant," Hanauer said of the GE plants' containment and cooling pool. "I recommend that [the government] adopt a policy of discouraging further use of pressure supression containments."

In a response five days later, Joseph M. Hendrie, later NRC chairman, called Hanauer's idea "an attractive one in some ways." But Hendrie had another concern about banning the GE design: "Reversal of this hallowed policy, particularly at this time, could well be the end of nuclear power," he wrote.

Hendrie, now a consultant, said GE containments "are perfectly good devices and the way we build them, they have a good deal more leeway than the attempted containment around that Russian graphite reactor."

Richard Swanson, Boston Edison's nuclear engineering manager, said the utility agreed with many of Hanauer's safety concerns and has spent $19 million over 10 years to correct them. It strengthened the donut-like structure around the cooling pool to ensure it would not come loose during an accident and "beefed up" protection of pipes and other key safety equipment.

Those changes do not impress Robert Pollard, a former NRC safety official now with the Union of Concerned Scientists.

"The Hanauer memo didn't recommend any changes to plants – for the reason that the problems are inherent in the design, and nothing can be done about them," he said.

The alternative would have been to build larger containment structures able to withstand greater volumes of steam, rather than relying on smaller shells equipped with cooling pools, Pollard said. GE did not do that, he said, "purely because of economics."

G.E. Wade, a nuclear designer at General Electric, agreed in a 1974 article in Nuclear Safety Magazine: Larger, dry containments like the ones Hanauer preferred "could not be designed which were economically competitive with pressurized water reactors" used by GE's main competitor, Westinghouse Electric Corp.

– Larry Tye

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